
Guidelines for Assessing Ecological Risks Posed by Chemicals

September 2000

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Preface

In an effort to promote consistency, efficiency and scientific rigor in ecological risk assessments conducted or reviewed by the California Environmental Protection Agency (Cal/EPA), the Office of Environmental Health Hazard Assessment (OEHHA) is developing the Cal/EPA *Guidelines for Assessing Ecological Risks Posed by Chemicals*. These guidelines are intended to encourage high quality, coordinated ecological risk assessments within Cal/EPA, and to foster a uniform approach to ecological risk assessment. In keeping with the goals of consistency and general applicability, the *Guidelines for Assessing Ecological Risks Posed by Chemicals* have adopted the general guidance provided in the United States Environmental Protection Agency (U.S. EPA) *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998). To supplement the U.S. EPA guidelines, the *Guidelines for Assessing Ecological Risks Posed by Chemicals* will include a number of focused guidance documents, tailored to meet the needs of Cal/EPA. These agency-wide guidelines will be developed sequentially, in ring-binder format, and will not supersede existing Cal/EPA program-specific guidelines. All parts of these guidelines will be reviewed by the Inter-Agency Work Group¹, a scientific peer group, and undergo public review as described in the *Guidelines for Assessing Ecological Risks Posed by Chemicals-Developmental Plan* (OEHHA, 1998). The *Developmental Plan* also describes in more detail the rationale and content of the technical resources documents to be developed by this Office. Throughout guidelines development, further input from interested parties will be sought to identify emerging priorities.

¹ The IAWG is composed of representatives from Cal/EPA Boards and Departments, including the Air Resources Board, Department of Pesticide Regulation, Department of Toxic Substances Control, Office of Environmental Health Hazard Assessment, State Water Resources Control Board and Regional Water Quality Control Boards, and the Department of Fish and Game of the Resources Agency.

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Guidelines for Assessing Ecological Risks Posed by Chemicals

PART I. Introduction

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Preface

This introductory chapter to the Cal/EPA *Guidelines for Assessing Ecological Risks Posed by Chemicals* provides an overview of ecological risk assessment and adopts the United States Environmental Protection Agency ecological risk assessment process for the Cal/EPA guidelines (U.S. EPA, 1998). Additionally, the format and scope of the Cal/EPA guidelines are briefly described. Previous drafts were reviewed by the Inter-Agency Work Group (IAWG)¹ and subsequently underwent public review. We greatly appreciate IAWG comments provided by Syed Ali, State Water Resources Control Board, and Brent Takemoto, Air Resources Board, as well as comments provided by various interested parties. This revised document contains changes based upon the comments received.

¹ The Inter-Agency Work Group is composed of representatives from Cal/EPA Boards and Departments, including the Air Resources Board, Department of Pesticide Regulation, Department of Toxic Substances Control, Office of Environmental Health Hazard Assessment, State Water Resources Control Board and Regional Water Quality Control Boards, and the Department of Fish and Game of the Resources Agency.

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Acronyms

Acronyms used in the document are listed below:

Acronym	Full Name
ARB	Air Resources Board, Cal/EPA
CAA	Clean Air Act
Cal/EPA	California Environmental Protection Agency
CDFG	California Department of Fish and Game, Resources Agency
CEQA	California Environmental Quality Act
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
DPR	Department of Pesticide Regulation, Cal/EPA
DTSC	Department of Toxic Substances Control, Cal/EPA
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
IAWG	Inter-Agency Work Group
HSAA	Hazardous Substances Account Act
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
OEHHA	Office of Environmental Health Hazard Assessment, Cal/EPA
OPR	Office of Planning and Research
RCRA	Resources Conservation and Recovery Act
RWQCB	Regional Water Quality Control Board, Cal/EPA
SARA	Superfund Amendments and Reauthorization Act
SWRCB	State Water Resources Control Board, Cal/EPA
U.S. EPA	United States Environmental Protection Agency
WDR	Waste Discharge Requirements

I. INTRODUCTION

Ecological risk assessment is a process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors (U.S. EPA, 1992). In this introduction, a brief history of the use of ecological risk assessment, as well as summaries of ecological risk assessment activities at the California Environmental Protection Agency (Cal/EPA) are provided. Additionally, the process leading to the development of Cal/EPA ecological risk assessment guidelines is summarized. The United States Environmental Protection Agency (U.S. EPA) ecological risk assessment process, as described in the *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998) is then briefly outlined and adopted as the overall approach for these Cal/EPA guidelines. Finally, the format and scope of the remaining parts of these guidelines are briefly described.

1. Ecological Risk Assessment: Linking Science to Regulatory Decision –Making

Elevated concern regarding the effects of pollution on the environment resulted in enactment of major federal and state legislation to protect human health and the environment, starting in the late 1940's (Figure 1). In order to evaluate compliance with these legislative mandates, several scientific assessment approaches were utilized and have been refined over the last two decades. Human health impacts associated with chemical exposures have been evaluated using methods developed within the fields of epidemiology and toxicology. Early on, however, it was recognized that decisions often had to be made on the basis of incomplete scientific knowledge and that specific processes were required for addressing this uncertainty (Ruckelshaus, 1983). One such decision-making process that has emerged from the actuarial methods of the insurance industry (e.g., likelihood of accidental deaths) is risk assessment and risk management. Risk assessment is a systematic process of describing and quantifying the probabilities of adverse effects (i.e., risks) associated with hazardous substances, processes, actions or events (Covello and Merkhofer, 1993). For public health purposes, risk assessment is generally defined as the characterization of the potential adverse health effects to humans through exposure to environmental hazards (National Research Council [NRC], 1983). Risk assessment findings provide scientific information for risk management actions, and together with political, social, legal, and economic factors influence decisions about the need for, method of, and extent of risk reduction (NRC, 1994).

A parallel track of method development for environmental or ecological assessment has occurred as well, but compared to human health, there has been a greater diversity of approaches derived from several scientific disciplines (Suter, 1993). Examples of environmental assessment methods include environmental impact assessments for listing potential effects of proposed projects, mathematical modeling techniques to evaluate human impacts on natural resources, and hazard assessment of chemical pollutants. As the practice of human risk assessment became more common in the 1980's, attention turned toward applying a similar process to assess effects of chemical, biological and physical stressors on

<u>California Environmental Legislation</u>	<u>Year</u>	<u>Major Federal Legislation</u>
	1947	Federal Insecticide, Fungicide, & Rodenticide Act (FIFRA); amended 1947 legislation
Hazardous Substance Act	1961	
	1963	Clean Air Act (CAA)
Mulford-Carrell Air Resources Act of 1967	1967	
Porter-Cologne Water Quality Control Act	1969	
California Environmental Quality Act (CEQA)	1970	Clean Air Act (Replaces CAA of 1963)
		National Environmental Policy Act
Hazardous Waste Control Law	1972	Federal Water Pollution Control Act (Clean Water Act)
California Wild and Scenic Rivers Act		Marine Protection, Research and Sanctuaries Act of 1972
	1973	Endangered Species Act
	1974	Safe Drinking Water Act
California Thermal Plan	1975	
California Safe Drinking Water Act	1976	Toxic Substances Control Act of 1976
California Coastal Act of 1976		Resources Conservation and Recovery Act of 1976 (RCRA)
Keene-Nejedly California Wetlands Preservation Act		
California Native Plant Protection Act	1977	Clean Air Act, amendments
Hazardous Waste Haulers Act	1979	Clean Water Act, amendments
Hazardous Substance Information and Training Act	1980	Comprehensive Environmental Response, Compensation & Liability Act of 1980 (CERCLA)
Carpenter-Prestley-Tanner Hazardous Substance Acct. Act	1981	
Toxic Air Contaminant Identification and Control Act	1983	
Underground Storage of Hazardous Substances Law		
SB 950 - Birth Defects Prevention Act	1984	Hazardous and Solid Waste Amendments of 1984 (RCRA amendments)
Toxic Pits Cleanup Act		
California Endangered Species Act		
Hazardous Materials Release Response Plans and Inventory	1985	
Toxic Injection Well Control Act		
Hazardous Waste Reduction, Recycling, and Treatment Research and Demonstration Act		
Pesticide Contamination Prevention Act		
Safe Drinking Water and Toxic Enforcement Act of 1986	1986	Superfund Amendments and Reauthorization Act of 1986 (SARA)
California Beverage Container Recycling and Litter Reduction Act		Emergency Planning and Community Right-to-Know Act
Air Toxics "Hot Spots" Information and Assessment Act	1987	Water Quality Act (Amendments to Clean Water Act)
California Clean Air Act	1988	FIFRA amendments
Atmospheric Acidity Protection Act		
AB 2161 - Food Safety Act		
California Integrated Waste Management Act of 1989	1989	
Amendments, California Safe Drinking Water Act		
Bay Protection and Toxic Clean-Up Act		
Lembert-Keene-Seastrand Oil Spill Prevention and Response Act	1990	Clean Air Act amendments
Marine Resources Protection Act		Oils Spill Prevention and Response Act
SB 48 - Rail Accidents	1991	
Natural Community Conservation Planning Act	1992	
Dry Cell Battery Management Act	1993	
SB 1082 - Environmental Protection, Regulations, Unified Hazardous Waste Program		

Figure 1. Examples of California and federal environmental laws

ecosystems, creating the discipline of ecological risk assessment. Although ecological risk assessment resembles prior ecological assessment approaches, it generally differs by including clear assessment endpoints, probabilistic methods, systematic procedures, documentation of assumptions and an emphasis on quantitative methods and results (Suter, 1993).

The NRC began to develop a conceptual framework for ecological risk assessment in 1989 (NRC, 1993), based on the human risk assessment paradigm. After several years of consensus-building among scientific experts, the U.S. EPA defined ecological risk assessment in a broad sense as “the process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors” (U.S. EPA, 1992). This definition recognizes that “likelihood” can be expressed in a quantitative or qualitative manner.

In 1992, the U.S. EPA developed a framework for conducting ecological risk assessments (U.S. EPA, 1992; described below) that was conceptually similar to that of the NRC for human health risk assessment (NRC, 1983), but there were fundamental differences in the types of information used and the complexity of the assessments. Unlike human risk assessments, ecological risk assessments generally; 1) assess a range of potential effects on multiple receptors (e.g., individuals, populations, communities or entire ecosystems), 2) extrapolate exposure or effects data for one or a few species to entire communities of species, 3) evaluate unique exposure pathways (e.g., root uptake), modes of action (e.g., eutrophication or eggshell thinning) and indirect effects (e.g., habitat or prey loss) and 4) evaluate chemical, biological (e.g. exotic species) and physical (e.g., sedimentation) stressors. Both human and ecological risk assessment approaches continue to evolve. The U.S. EPA has outlined a proposal to integrate human and ecological risk assessments, focusing on multi-media and cumulative impact assessment (U.S. EPA, 1996a). The potentially complex nature of ecological risk assessments has presented a challenge to those developing and refining guidance and methodology.

Despite the challenges presented by ecological risk assessment, it provides a scientific, objective basis for regulatory decision-making. Ecological risk assessment outlines a systematic process for defining the problem, organizing and analyzing data, defining assumptions and uncertainties and characterizing risks. Through quantifying and comparing risks of various options and actions, ecological risk assessment can serve to 1) identify problems and select targets for regulation; 2) set priorities for environmental protection; 3) compare effectiveness of risk management options; and 4) identify research needs. Ecological risk assessment can be particularly valuable for predicting potential ecological effects in cases where field experimentation is not possible, such as prior to stressor exposure or future effects that may result from existing exposures. It is also helpful in situations where exposure to multiple stressors may result in a complex array of adverse ecological effects. The process accommodates the required coordinated, multi-disciplinary approach, assists in defining the complex problem to be assessed and acknowledges the scientific uncertainties of the analysis.

2. Ecological Risk Assessment at Cal/EPA

The protection of California's environment is under the primary responsibility of two umbrella organizations, the Resources Agency and Cal/EPA. Cal/EPA was created in 1991 as part of a reorganization of State government by Governor Pete Wilson, and, like the Resources Agency, consists of several boards and departments (Table 1). Each Cal/EPA board and department has specific mandates and responsibilities for environmental protection, many of which are coordinated with the Resources Agency. As a broad generalization, the Resources Agency's responsibilities include primarily protection and management of biological and land resources whereas Cal/EPA's mandates are directed toward preventing and reducing chemical pollution of the environment.

Recognizing the benefits of ecological risk assessment, Cal/EPA has incorporated this approach into a wide variety of regulatory decision making. Various Cal/EPA agencies currently conduct or review ecological risk assessments with the goal of assessing impacts of chemicals or other stressors on entire ecosystems or ecosystem components. The uses of ecological risk assessment encompass many different prospective and retrospective assessments, including:

- *Pesticide assessments:* The Department of Pesticide Regulation (DPR) registers pesticides for use in California and re-evaluates pesticides already in use. In addition, post-registration assessments of pesticides already in use are carried out as part of special reviews or re-registration procedures.
- *Hazardous waste site and permitted facilities assessments:* Under its responsibility to investigate State and federal Superfund sites, and to oversee the permitting of sites and facilities that treat, store, or dispose of hazardous waste, the Department of Toxic Substances Control (DTSC) conducts or oversees ecological risk assessments at hazardous waste sites. DTSC's ecological risk assessment approach assists responsible parties or permitted facilities in their mitigation or remediation processes.
- *Water quality:* The quality of the State's waters is assessed by the State Water Resources Control Board (SWRCB) and its nine Regional Water Quality Control Boards (RWQCB) which develop and enforce water quality objectives and conduct water quality monitoring. These water quality objectives, chemical-specific or toxicity criteria designed to protect human health and aquatic life, are generally used as endpoints for assessing potential risks to the beneficial uses of waters (Bascietto *et al*, 1990). Water quality monitoring studies typically follow the general ecological risk assessment process.
- *Air quality:* The Air Resources Board (ARB) monitors the State's air quality and sets air quality standards to promote and protect public health, welfare and ecological resources.
- *General:* The Office of Environmental Health Hazard Assessment (OEHHA) provides support as needed to other Boards and Departments within Cal/EPA, including development of guidelines and technical resources for ecological risk assessment.

Examples of current risk assessment activities at Cal/EPA and other State agencies are provided in Appendix IA.

Table 1. The Mission and Organizational Structure of the California Environmental Protection Agency and the California Resources Agency

California Environmental Protection Agency <i>The mission of the California Environmental Protection Agency is to improve environmental quality in order to protect public health, the welfare of our citizens, and California's natural resources. Cal/EPA will achieve its mission in an equitable, efficient, and cost-effective manner.</i>			
BOARDS		DEPARTMENTS	
<ul style="list-style-type: none"> • Air Resources Board • Integrated Waste Management Board • State Water Quality Control Board • Regional Water Quality Control Boards 		<ul style="list-style-type: none"> • Department of Toxic Substances Control • Department of Pesticide Regulation • Office of Environmental Health Hazard Assessment 	

California Resources Agency <i>The California Resources Agency is responsible for the conservation, enhancement, and management of California's natural and cultural resources, including land, water, wildlife, parks, minerals, and historic sites.</i>			
DEPARTMENTS	BOARDS	CONSERVANCIES	COMMISSIONS
<ul style="list-style-type: none"> • Department of Boating and Waterways • Department of Conservation • Department of Fish and Game • Department of Forestry and Fire Protection • Department of Parks and Recreation • Department of Water Resources • California Conservation Corps 	<ul style="list-style-type: none"> • State Reclamation Board • Board of Forestry • Mining and Geology Board • Colorado River Board of California 	<ul style="list-style-type: none"> • Coachella Valley Conservancy • San Joaquin River Conservancy • Santa Monica Mountains Conservancy • State Coastal Conservancy • California Tahoe Conservancy 	<ul style="list-style-type: none"> • California Energy Commission • California State Lands Commission • San Francisco Bay Conservation and Development Commission • Delta Protection Commission • Fish and Game Commission • Native American Heritage Commission • Parks and Recreation Commission • State Historic Resources Commission • California Water Commission • California Coastal Commission

3. Ecological Risk Assessment Guidance Development at Cal/EPA: Adoption of the U.S. EPA Guidelines for Ecological Risk Assessment

Considering the potentially broad use of ecological risk assessment among Cal/EPA Boards and Departments, Cal/EPA has charged the Office of Environmental Health Hazard Assessment (OEHHA) with the responsibility of developing agency-wide guidelines for ecological risk assessment. The intent of these guidelines is to provide an information resource and to promote consistency, efficiency and scientific rigor in ecological risk assessment procedures used by Cal/EPA Boards and Departments. The Cal/EPA agency-wide guidelines do not supersede program-specific guidance but are available for adoption at the discretion of the Boards and Departments. Useful program-specific guidance documents have been developed by various programs within Cal/EPA (e.g., DTSC, 1996) and other state and federal agencies (see Appendix IB).

In 1995, OEHHA began the guidelines development process by conducting a series of public workshops to identify needed ecological risk assessment guidance in California (OEHHA, 1995). Recommendations from the workshops were evaluated and OEHHA drafted a plan for guidelines development. At the same time, U.S. EPA released a public draft of the *Proposed Guidelines for Ecological Risk Assessment* (U.S. EPA, 1996b), which built upon the earlier framework proposed by U.S. EPA (U.S. EPA, 1992). Following review of the U.S. EPA *Proposed Guidelines*, OEHHA released the *Guidelines for Assessing Ecological Risks Posed by Chemicals – Developmental Plan* for public review and finalized the document in 1998 (OEHHA, 1998). The plan proposed to adopt the U.S. EPA guidelines, when finalized, and to augment the guidelines with a series of technical resource documents tailored to meet California's needs. U.S. EPA finalized the *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998) and OEHHA has completed a review of the document.

The review has concluded that the U.S. EPA *Guidelines for Ecological Risk Assessment* provides an appropriate scientific process for conducting and evaluating ecological risk assessments. The U.S. EPA guidelines are broadly interpretable, within the general framework, such that diverse risk assessment scenarios evaluated by Cal/EPA can be accommodated. OEHHA, therefore, will adhere to the original proposal outlined in the *Developmental Plan* (OEHHA, 1998) and will adopt the general ecological risk assessment process outlined by U.S. EPA (1998) as the basis for the Cal/EPA *Guidelines for Assessing Ecological Risks Posed by Chemicals*. The *Guidelines for Ecological Risk Assessment* (U.S. EPA, 1998) describes the basic process of ecological risk assessment which involves three primary phases: problem formulation, analysis, and risk characterization (Figure 2 ; see also Attachment I-A for a copy of the U.S. EPA *Guidelines for Ecological Risk Assessment*).

- In the problem formulation phase of an ecological risk assessment, the purpose of the assessment is outlined, the problem is defined and a plan for analyzing and characterizing risk is determined. The risk assessors evaluate goals and select assessment endpoints, prepare the conceptual model and analysis plan.

- During the analysis phase, exposure to stressors and the relationship between stressor levels and ecological effects are characterized. This involves scientific evaluation of relevant data, developed or pre-existing, in order to prepare an exposure profile and a stressor-response profile.
- Risk characterization involves estimating risk by integrating exposure and stressor-response profiles, describing the risk by discussing lines of evidence and determining adverse ecological effects. Risk characterization includes a summary of assumptions, scientific uncertainties, and strengths and limitations of the analyses.

Cal/EPA Boards and Departments should keep the following points in mind when utilizing the U.S. EPA *Guidelines for Ecological Risk Assessment*:

- Since ecological risk assessments conducted or reviewed by Cal/EPA typically evaluate chemical stressors or physical and biological stressors when they co-occur with chemical stressors, some examples in the U.S. EPA *Guidelines for Ecological Risk Assessment* may not be directly applicable to Cal/EPA risk assessment scenarios (e.g. those where biological or physical stressors are examined individually).
- Specific test methods mentioned in the U.S. EPA *Guidelines for Ecological Risk Assessment* may not necessarily meet assessment needs of Cal/EPA, as the document was primarily designed for U.S. EPA programs.

Taking these caveats into account, adoption by Cal/EPA of the ecological risk assessment process outlined in the U.S. EPA *Guidelines for Ecological Risk Assessment* will promote consistency at both the State and federal level.

4. Cal/EPA Ecological Risk Assessment Guidelines: Format and Scope

California-specific assessment needs will be addressed by developing technical resource documents in the areas outlined in the *Developmental Plan* (OEHHA, 1998). These technical resource documents along with the U.S. EPA *Guidelines for Ecological Risk Assessment* (Attachment I-A) will form the overall Cal/EPA *Guidelines for Assessing Ecological Risks Posed by Chemicals*. The technical resource documents will be released in a phased manner, in ring-binder format, and organized within one of three parts: Part 2. Problem Formulation, Part 3. Analysis or Part 4. Risk Characterization. To ensure that the technical resource documents meet the needs of the Cal/EPA ecological risk assessment community, OEHHA will seek input from interested parties via the tiered review approach previously described in the *Developmental Plan* (OEHHA, 1998).

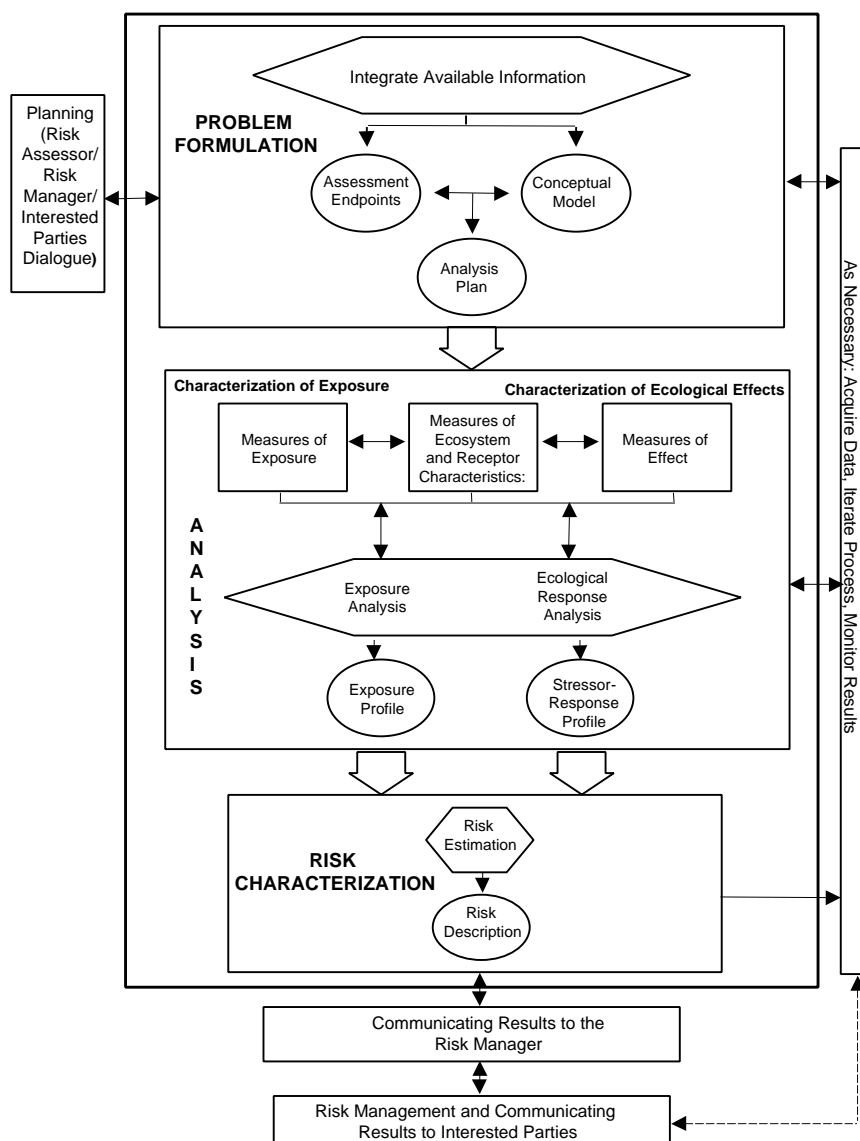


Figure 2. Schematic diagram of the ecological risk assessment process from the U.S. EPA Guidelines for Ecological Risk Assessment (U.S. EPA, 1998)

Briefly, for each technical resource document, a detailed outline and initial drafts will be reviewed internally by the Inter-Agency Work Group¹ (IAWG). Each document will then undergo technical review by external peer reviewers, selected on an *ad hoc* basis, ensuring balanced representation from government, academia, non-profit/environmental groups and the private sector. Following appropriate revision, the documents will be released for a 60-day public comment period.

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¹ The IAWG is composed of representatives from Cal/EPA Boards and Departments, including the Air Resources Board, Department of Pesticide Regulation, Department of Toxic Substances Control, Office of Environmental Health Hazard Assessment, State Water Resources Control Board and Regional Water Quality Control Boards, and the Department of Fish and Game of the Resources Agency.

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APPENDIX IA

Examples of Cal/EPA Ecological Risk Assessment Activities

A. Chemical Risk From Hazardous Waste Sites	IA-2
B. Chemical and Physical Injuries from Oil and Hazardous Chemical Spills	IA-3
C. Chemical Risks from Prospective Pesticide Use	IA-4
D. Chemical, Biological, and Physical Risks to the Environment as a Result of a Prospective Project.....	IA-5
E. Chemical Risk From Discharges to Water	IA-6
F. Chemical Risk From Acidic Deposition.....	IA-7

Ecological Risk Assessment Example A

Risk: Chemical Risk From Hazardous Waste Sites

Mandates: Comprehensive Environmental Response Compensation and Liability Act (CERCLA); Superfund Amendments and Reauthorization Act (SARA) of 1986; Carpenter-Presley-Tanner Hazardous Substance Account Act (HSAA); California Health and Safety Code Sections 25201, 25351, 25355 and 25358.

Agencies Involved: DTSC; CDFG; SWRCB; RWQCBs; OEHHA

Assessment Objective: To predict potential adverse effects and when appropriate, to measure existing adverse effects, of chemical contaminants on the biota on or near a site, and to determine levels of those chemicals in the environment that would not be expected to adversely affect the biota (DTSC, 1996). This assessment may be a part of CERCLA's remedial investigation/feasibility study process.

Assessment Type: Site-specific, phased ecological risk assessment. The phased approach may include a Scoping Assessment, a Predictive Ecological Risk Assessment (Phase I), a Validation Study (Phase II) and an Impact Assessment (Phase III).

Assessment Procedure:

Problem formulation. During the Scoping Assessment, a conceptual site model is produced, contaminants of concern and ecological receptors are identified for the site and the potential for contact between ecological receptors and chemicals of concern is established. Site-specific history, chemical analysis of media and biological surveys are used to develop lists of contaminants and receptors of concern. During the second phase, the Predictive Ecological Risk Assessment, assessment and measurement endpoints are selected based on the conceptual site model.

Analysis. Reference doses or concentrations are identified for each contaminant and receptor of concern during the Predictive Ecological Risk Assessment. Site-specific toxicity data may also be collected during this phase or the later Validation Study and Impact Assessment phases. Contaminant concentrations in media and biota may be predicted from models or measured directly to estimate the daily intake for each receptor. All complete direct and indirect exposure pathways are evaluated.

Risk Characterization. During the Predictive Assessment a hazard quotient is calculated for each species under evaluation. Hazard quotients for all exposure pathways may be added to arrive at a species-specific hazard index. Probabilistic methods may be employed in later phases of the assessment.

Reference:

California Department of Toxic Substances Control (DTSC). 1996. Draft Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Parts A: Overview. Sacramento, CA: California Environmental Protection Agency. 84 p.

Ecological Risk Assessment Example B

Risk: **Chemical and Physical Injuries from Oil and Hazardous Chemical Spills**

Mandates: Lember-Keene-Seastrand Oil Spill Prevention and Response Act of 1990; Oil Pollution Act of 1990; Comprehensive Environmental Response Compensation and Liability Act (CERCLA); Clean Water Act Amendments of 1977

Agencies Involved: CDFG; DTSC; SWRCB; RWQCBs; OEHHA

Assessment Objective: To identify and quantify injury to natural resources, to determine the damages (both ecological and economical) resulting from the injury, and to develop and implement restoration actions.

Assessment Type: Site-specific, phased Natural Resource Damage Assessment (NRDA). A NRDA is composed of the following phases; pre-assessment, damage assessment plan, restoration planning and implementation.

Assessment Procedure:

Problem formulation. The primary objective of the assessment is to determine whether injury to natural resources has occurred, based on specific definitions of injury to biotic and abiotic resources. In general, injury is defined as an observable or measurable adverse change in a natural resource or impairment of a service. The exposure pathways from the oil discharge or release of hazardous substance to the injured resource is documented.

Analysis. For each resource, the effects of the hazardous substance are measured and baseline conditions, loss of services and resource recoverability are determined.

Risk Characterization. The damages resulting from oil discharge or hazardous substance release are estimated and the monetary value of the injured resource is determined so that appropriate compensation may be sought.

Reference:

U.S. Department of the Interior. Natural Resource Damage Assessments. 43 CFR Part 11.10-93.

Ecological Risk Assessment Example C

Risk: **Chemical Risks from Prospective Pesticide Use**

Mandates: Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA); Pesticide Contamination Prevention Act; Birth Defects Prevention Act

Agencies Involved: DPR; SWRCB; RWQCBs; CDFG

Assessment Objective: To evaluate the likelihood of unreasonable, adverse effects to non-target species, including endangered species, as a result of estimated pesticide exposure.

Assessment Type: Chemical-specific, tiered ecological risk assessment. The assessment is based on up to four tiers of toxicity testing, ranging from acute toxicity screening to field testing (Urban and Cook, 1986). Due to the large degree of harmonization between U.S. EPA and DPR, additional ecological testing is generally not required by DPR if compliance with federal regulations is shown.

Assessment Procedure:

Problem formulation. The assessment endpoint is protection of aquatic and terrestrial species from unreasonable, adverse effects due to exposure to the pesticide. Surrogate aquatic invertebrate, aquatic plant, fish, avian and mammalian species are utilized to evaluate effects on mortality, growth, development and reproduction.

Analysis. Adverse effects are estimated by conducting a tiered series of testing ranging from acute and chronic bioassays to field testing to generate dose-response relationships. Expected environmental concentrations are generally predicted from models but may be measured during later tiers of field testing.

Risk Characterization. The hazard quotient method has been the standard approach used for evaluating potential risks of pesticides. However, recent efforts by the U.S. EPA to improve pesticide assessments have resulted in the development of probabilistic methodologies, implementation plans for which are currently underway.

References:

- Urban, D.J. and N.J. Cook. 1986. Ecological Risk Assessment. Hazard Evaluation Division Standard Evaluation Procedure. Washington D.C.: Office of Pesticide Programs, U.S. Environmental Protection Agency. EPA-540/9-85-001. 96 p
- U.S. Environmental Protection Agency. 2000. The Office of Pesticide Programs. Ecological Risk Assessment Page, OPP's Initiative to Revise the Ecological Assessment Process (<http://www.epa.gov/oppefed1/ecorisk/index.htm>).
- U.S. Environmental Protection Agency. 2000. Implementing Probabilistic Ecological Assessments: A Consultation. FIFRA Scientific Advisory Panel (SAP), April 5-7, 2000 (<http://www.epa.gov/scipoly/sap/>).
- U.S. Environmental Protection Agency. 1999. Higher Tier Ecological Risk Assessment for Chlorfenapyr. FIFRA Scientific Advisory Panel (SAP), July 22-23, 1999. (<http://www.epa.gov/scipoly/sap/1999/index.htm>).
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Ecological Risk Assessment Example D

Risk: **Chemical, Biological, and Physical Risks to the Environment as a Result of a Prospective Project**

Mandates: California Environmental Quality Act (CEQA)

Agencies Involved: CDFG; SWRCB; RWQCBs

Assessment Objective: To evaluate whether an activity may cause either direct physical change in the environment, or a reasonably foreseeable indirect physical change in the environment, including land, air, water, flora, fauna.

Assessment Type: Site-specific Environmental Impact Report. Depending on the size of the project, a tiered approach may be adopted (OPR, 1995).

Assessment Procedure:

Problem formulation. The assessment endpoints are relatively well defined and consist of a list of approximately twenty-six criteria that can be used to determine if a project may have a significant effect on the environment. Examples include a project that will substantially affect a rare or endangered species of animal or plant or the habitat of the species, substantially degrade water quality or violate ambient air quality standards.

Analysis. Methodologies for exposure or effects assessment vary considerably, ranging from qualitative to quantitative assessments that utilize probabilistic methods.

Risk Characterization. Determination if the project will have a significant effect on the environment generally involves a qualitative risk comparison between proposed alternatives. However, quantitative risk characterization has been employed.

Reference:

Office of Planning and Research (OPR). 1995. California Environmental Quality Act Statutes and Guidelines. Sacramento, CA: Governor's Office of Planning and Research. 181 p.

Ecological Risk Assessment Example E

Risk: Chemical Risk From Discharges to Water

Mandates: Clean Water Act; Porter-Cologne Water Quality Control Act; California Ocean Plan, California Water Code Sections 13170 and 13170.2; Bay Protection and Toxic Cleanup Program, California Water Code Sections 13390 et seq.

Agencies Involved: SWRCB; RWQCBs; OEHHA

Assessment Objective: To identify concentrations of toxic substances, including U.S. EPA priority pollutants, that are potentially harmful to freshwater, estuarine or marine aquatic life. Physical stressors, such as sediments and temperature, and biological stressors, such as pathogenic bacteria and viruses, may also be evaluated.

Assessment Type: Chemical-specific ecological risk assessment. For point sources, numerical or narrative water quality objectives for the protection of human health and aquatic life are used by the RWQCBs in issuing Waste Discharge Requirement (WDR) permits. Subsequent monitoring may be utilized to evaluate permit compliance. For non-point source or watershed level assessment, numerical and narrative water quality objectives for the protection of aquatic life are used in combination with monitoring programs (U.S. EPA, 1991).

Assessment Procedure:

Problem Formulation. The assessment endpoints are often the survival, growth and reproduction of fish, aquatic invertebrates and algal species.

Analysis. Numerical water quality criteria for chemical pollutants, developed from laboratory aquatic toxicity tests for acute and chronic exposures, may be utilized for the effects assessment. Alternatively, site-specific ambient water/effluent toxicity testing or field bioassessment studies may be completed. Exposure is generally evaluated by direct monitoring of chemical concentrations in the effluent, receiving water, sediment or biota.

Risk Characterization. Media concentrations and/or site-specific toxicity data are compared to numerical or narrative water quality objectives in many cases. Monitoring programs may also use a weight of evidence approach to evaluate results of chemical monitoring, toxicity testing and bioassessment activities.

Reference:

U.S. Environmental Protection Agency. 1991. Technical Support Document for Water Quality-based Toxics Control. Washington D.C.: Office of Water, U.S. Environmental Protection Agency. EPA/505/2-90-001. 139 p.

Ecological Risk Assessment Example F

Risk: Chemical Risk From Atmospheric Deposition

Mandates: Atmospheric Acidity Protection Act.

Agencies Involved: ARB

Assessment Objective: To determine the long-term trends and effects of wet- and dry-deposited forms of atmospheric acidity, nitrogen, and sulfur in California, including impacts on lake and stream chemistry in sensitive watersheds and effects on forests. Assessments may contribute to the development of standards which could be necessary and appropriate to protect sensitive ecosystems from adverse effects resulting from atmospheric acidity, nitrogen, and/or sulfur.

Assessment Type: Chemical-specific ecological risk assessment.

Assessment Procedure:

Problem Formulation. Watersheds and forest ecosystems vulnerable to acidification are identified. Indicator species are selected to evaluate the biological impacts of acidification on these ecosystems.

Analysis. Air quality monitoring is conducted to measure wet- and dry-deposited acidic air pollutants, to estimate rates of acid, nitrogen, and sulfur deposition, and to identify temporal and spatial trends in air pollutant concentrations and deposition. For sensitive high-elevation watersheds, changes in water chemistry and effects on biota were investigated. In mid-elevation forests, the health of vegetation and condition of soil was monitored.

Risk Characterization. Exposure and effects information are generally compared in a qualitative sense, including comparison to literature toxicity data.

References:

Takemoto B.K. et al., 1995. Acidic deposition in California: Findings from a program of monitoring and effects research. *Water, Air, and Soil Pollution*, 85, 261-272.

California Air Resources Board, 1994. *The Atmospheric Acidity Protection Program: Annual Report to the Governor and the Legislature, 1993*. Research Division, Sacramento, California. 86 pp.

APPENDIX IB-1

Bibliography of Ecological Risk Assessment Guidance Documents

Bibliography of Ecological Risk Assessment Guidance Documents

Ecological risk assessment guidelines have been developed for a variety of applications by a number of governmental agencies. This bibliography, although not comprehensive, was developed to illustrate the diversity of available program-specific ecological risk assessment guidance.

Ecological Risk Assessment-General Guidance

Sorensen, M. T. and J. A. Margolin. 1998. Ecological risk assessment guidance and procedural documents: an annotated compilation and evaluation of reference materials. *Human and Ecological Risk Assessment* 4:1085-1101.

Environmental Impact -Related Guidance

Office of Planning and Research. 1995. California Environmental Quality Act Statutes and Guidelines. Sacramento, CA: Governor's Office of Planning and Research. 181 p.

U.S. Food and Drug Administration. 1987. Environmental Assessment Technical Assistance Handbook. Washington, D.C.: Center for Food Safety and Applied Nutrition, Food and Drug Administration. NTIS PB87-175345. 380 p.

Hazardous Waste-Related Ecological Risk Assessment Guidance

Alaska Department of Environmental Conservation. 1996. Risk Assessment Procedures Manual, Draft. Fairbanks, AK: Contaminated Sites Remediation Program, Alaska Department of Environmental Conservation. 99 p.

Barnthouse, L.W., G.W. Suter, S.M. Bartell, J.J. Beauchamp, R.H. Gardner, E. Linder, R.V. O'Neill, A.E. Rosen. 1986. User's Manual for Ecological Risk Assessment. Oak Ridge, TN: Oak Ridge National Laboratory. Environmental Sciences Division Publication No. 2679.

California Department of Toxic Substances Control. 1996. Draft Guidance for Ecological Risk Assessment at Hazardous Waste Sites and Permitted Facilities, Parts A and B. Sacramento, CA: California Environmental Protection Agency. (<http://www.cwo.com/~herd1/>)

Landis, W.G., A.J. Markiewicz, V. Wilson, A. Fairbrother and G. Mann. 1998. Recommended Guidance and Checklist for Tier 1 Ecological Risk Assessment of Contaminated Sites in British Columbia. Vancouver, British Columbia: British Columbia Ministry of Environment, Lands and Parks.

Oregon Department of Environmental Quality. 1998. Guidance for Ecological Risk Assessment, Level III - Baseline and Level IV – Field Baseline. Portland, OR: Waste Management and Cleanup Division, Oregon Department of Environmental Quality. (<http://www.deq.state.or.us/wmc/cleanup/>)

Oregon Department of Environmental Quality. 1997. Guidance for Ecological Risk Assessment, Level I - Scoping and Level II – Screening. Portland, OR: Waste Management and Cleanup Division, Oregon Department of Environmental Quality. (<http://www.deq.state.or.us/wmc/cleanup/>)

Texas Natural Resource Conservation Commission. 1996. Guidance for Conducting Ecological Risk Assessments Under the Texas Risk Reduction Program, Draft.

- Austin, TX: Office of Waste Management, Texas Natural Resource Conservation Commission. RG-263.
- U.S. Department of Energy. 1994. Incorporating Ecological Risk Assessment into Remedial Investigation/Feasibility Work Plans. Washington, D.C.: Office of Environmental Guidance, U.S. Department of Energy. DOE/EH-0391.
- U.S. Environmental Protection Agency. 1997. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final. Edison, NJ: Solid Waste and Emergency Response, U.S. Environmental Protection Agency. EPA 540-R-97-006.
- Victorian Environmental Protection Authority for Environment Australia. 1997. National Framework for Ecological Risk Assessment of Contaminated Sites, Part A. Framework Description, Draft. Kingston, Australia: Contaminated Sites Section, Environment Australia. 45 p.
- Warren-Hicks, W., B.R. Parkhurst and S.S. Baker, Jr. 1989. Ecological Assessments of Hazardous Waste Sites: A Field and Laboratory Reference Document. Washington, D.C.: Environmental Research Laboratory, Corvallis, OR, U.S. Environmental Protection Agency. EPA 600/3-89/013.
- Washington Department of Ecology. 1996. Cleaning up MTCA Sites to Protect the Environment; A Guide to the Model Toxics Control Act Environmental Evaluation Process for Soil Contamination, Draft. Toxics Cleanup Program, Environmental Evaluation. Olympia, WA: Washington Department of Ecology. 23 p. (<http://www.wa.gov/ecology/tcp/cleanup.html>).
- Wentzel, R.S., T.W. LaPoint, M. Simini, R.T. Checkai, D. Ludwig, and L. Brewer. 1996. Procedural Guidelines for Ecological Risk Assessments, Volume I. Aberdeen Proving Ground, MD: U.S. Army Edgewood Research, Development and Engineering Center. 108 p.

Natural Resource Damage Assessment-Related Ecological Risk Assessment Guidance

- Huguenin, M.T., D.H. Haury, J.C. Weiss, D. Helton, C. Manen, E. Reinharz, and J. Michel. 1996. Injury Assessment, Guidance Document for Natural Resource Damage Assessment Under the Oil Pollution Act of 1990. Washington, D.C.: Damage Assessment and Restoration Program, National Oceanic and Atmospheric Administration. (<http://www.darcnw.noaa.gov/opa.htm>)
- U.S. Department of the Interior. Natural Resource Damage Assessments. 43 CFR Part 11.10-93.

Pesticide Registration-Related Ecological Risk Assessment Guidance

- Urban, D.J. and N.J. Cook. 1986. Ecological Risk Assessment. Hazard Evaluation Division Standard Evaluation Procedure. Washington D.C.: Office of Pesticide Programs, U.S. Environmental Protection Agency. EPA-540/9-85-001. 96 p.

Toxic Substances -Related Ecological Risk Assessment Guidance

- Environment Canada. 1997. Environmental Assessments of Priority Substances Under the Canadian Environmental Protection Act. Hull, Quebec: Chemicals Evaluation Division, Commercial Chemicals Evaluation Branch, Environment Canada. EPS/2/CC/3E. (<http://www.ec.gc.ca>)

Zeeman, M. and J. Gilford. 1993. Ecological Hazard Evaluation and Risk Assessment Under EPA's Toxic Substances Control Act (TSCA): An Introduction. In: Landis, W.G., J.S. Hughes and M.A. Lewis, eds. Environmental Toxicology and Risk Assessment. ASTM STP 1179. Philadelphia, PA: American Society for Testing and Materials. pp. 7-21.

Water Quality Related Ecological Risk Assessment Guidance

State Water Resources Control Board. 1998. Functional Equivalent Document, Amendment of the Water Quality Control Plan for Ocean Waters of California. Draft. October, 1998. State Water Resources Control Board. California Environmental Protection Agency. Sacramento, CA.
<http://www.swrcb.ca.gov/html/plnspols.html>

State Water Resources Control Board. 2000. Policy for Implementation of Toxics Standards for Inland Surface Waters, Enclosed Bays, and Estuaries of California (Phase 1 of the Inland Surface Waters Plan and Enclosed Bays and Estuaries Plan). Draft. January 24, 2000. State Water Resources Control Board. California Environmental Protection Agency. Sacramento, CA.

Stephen, C.E., D.I. Mount, D.J. Hansen, J.H. Gentile, G.A. Chapman and W.A. Brungs. 1985. Guidelines for Deriving Numerical Water Quality Criteria for the Protection of Aquatic Organisms and Their Uses. Duluth, MN: Office of Research and Development, U.S. Environmental Protection Agency. PB 85-227049.

U.S. Environmental Protection Agency. 1991. Technical Support Document for Water Quality-based Toxics Control. Washington D.C.: Office of Water, U.S. Environmental Protection Agency. EPA/505/2-90-001. 139 p.

U.S. Environmental Protection Agency. 1995. Great Lakes Water Quality Initiative Technical Support Document for Wildlife. Washington D.C.: Office of Water, U.S. Environmental Protection Agency. EPA/820/B-95/009.

ATTACHMENT I-A

**U.S. EPA. 1998. Guidelines for Ecological Risk Assessment.
Washington D.C.: USEPA. EPA/630/R-95/002F. (159
pages)**

**(a copy of the document may be obtained at
<http://www.epa.gov/ncea/>)**